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ABSTRACT

This paper focuses on the methodology of cross group comparisons of regression coefficients commonly used to identify group differences in status attainment. Using the study of race differences in educational attainment as an example, the paper reviews a number of relevant published studies and demonstrates that evidence for such differences is inconsistent across studies, that differences in the regression coefficients are subject to artifactual sources of fluctuation, and that statistical inferences based on such differences are weak. The paper concludes that the study of statistical interactions requires the design of creative studies and data collection strategies that anticipate and compensate for such problems as inadequate data, differential measurement properties, and differences in the sampling frame. (MJL)

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BLACK-WHITE DIFFERENCES IN THE EDUCATIONAL ATTAINMENT PROCESS: WHAT HAVE WE LEARNED?

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Introductory Statement

The Center for Social Organization of Schools has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organization.

The Center works through five programs to achieve its objectives. The Studies in School Desegregation program applies the basic theories of social organization of schools to study the internal conditions of desegregated schools, the feasibility of alternative desegregation policies, and the interrelations of school desegregation with other equity issues such as housing and job desegregation. The School Organization program is currently concerned with authority-control structures, task structures, reward systems, and peer group processes in schools. It has produced a large-scale study of the effects of open schools, has developed Student Team Learning Instructional processes for teaching various subjects in elementary and secondary schools, and has produced a computerized system for school-wide attendance monitoring. The School Process and Career Development program is studying transitions from high school to post secondary institutions and the role of schooling in the development of career plans and the actualization of labor market outcomes. The Studies in Delinquency and School Environments program is examining the interaction of school environments, school experiences, and individual characteristics in relation to in-school and later-life delinquency.

The Center also supports a Fellowships in Education Research program that provides opportunities for talented young researchers to conduct and publish significant research, and to encourage the participation of women and minorities in research on education.

This report, prepared by the School Processes and Career Development program, examines some methodological problems involved in the study of black-white differences in the educational attainment process.

Abstract

Differences in the status attainment process for groups are often inferred from differences in corresponding regression coefficients when structural equations models are seperately estimated for each group. This paper examines the credibility of inferences based on cross-group comparisons of regression coefficients using black-white differences in the educational attainment process as an example. It reviews evidence about race differences from previous studies and finds inconsistencies. Reanalyses of the data from these studies using common models and methods fails to produce consistent results. Additional reason for caution in substantive interpretation of differences in regression coefficients is illustrated using NLS data in which a large portion of the subgroup differences in regression coefficients can easily be interpreted as due to black-white differences in the measurement properties of the observed variables. Other sources of regression slope fluctuation that may arise from methodological rather than substantive processes are also illustrated. Evidence implies that regression slope differences across groups in models of attainment provide ambiguous evidence on which to base statements about differences in the attainment process.

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In 1980, five of the twenty-nine articles published in the American Sociological Review used cross-group comparisons of regression coefficients as evidence for differences between groups in some social process, usually status attainment. This paper focuses on the methodology commonly used to identify such group differences in the status attainment tradition. Using the study of race differences in educational attainment as an example, it demonstrates that evidence for such differences is inconsistent across studies, that differences in the regression coefficients are subject to many artifactual sources of fluctuation, and that statistical inferences based on such differences are weak at best.

The availability of data and amount of previous research determined the choice of groups used to develop the theme of this paper. Only comparative studies of the educational attainment of black and white males were sufficiently abundant to allow for a sensible cross study comparison. I will begin with a brief review of the relevent status attainment literature.

Duncan's (1968) analysis of the Occupational Change in a Generation (OCG) data provided a landmark for subsequent analyses of racial inequality in the status attainment process. That study suggested that the problem of racial inequality is twofold: Blacks enter the occupational structure with an initial disadvantage (i.e., the mean level of socioeconomic status of parents is lower for blacks than for whites), and blacks do not get as high a return for their resources (i.e., the regression slope of attainment on background factors is not as steep for blacks as for whites).

Duncan implicitly used black-white comparisons of regression coefficients and intercepts as evidence that even if blacks were to enter the labor force with the same "advantage" as whites they would nevertheless end up in lower prestige occupations and with lower earnings as a result of "occupational discrimination" (p. 108).

A decade of modification, elaboration and replication of Duncan's model and findings aimed at understanding the mechanisms of inequality has ensued. Attempts to specify in what ways the educational process differs for blacks and whites have elaborated Duncan's model to include measures of noncognitive socialization variables such as self-esteem and conformity (Porter, 1974; Portes and Wilson, 1976) as well as allocation variables such as curriculum placement (Thomas, 1980). Interpretations of race differences in regression coefficients for the models have ranged from socialization to allocation explanations (Kerckhoff, 1976). Socialization explanations assume that (a) certain nonintellective skills or access to information promote future attainments, and that (b) individuals or groups whose socialization experiences have been deficient in training for these skills lack these personal characteristics that would enable them to "work the system," i.e., to translate certain resources into rewards. Allocation explanations assume that individuals are assigned to social statuses partly on the basis of race and that attainment depends not on earned merit but on membership in an elite status.

These elaborations of the Blau-Duncan model have clarified some issues with regard to the interactions of race with other variables in the educational attainment model, but have also raised new questions that remain unanswered. Duncan's observation that the regression coefficients for blacks are in general lower than for whites has been replicated

several times, but the specific differences between coefficients have appeared only inconsistently across studies.

The literature on race differences in regression slopes is extensive but lacking in integration. Because the studies reviewed differ in many ways, direct comparisons of their results are usually inappropriate. Differences across studies may result from cohort or time differences because the data were collected at different times (base years range from 1960 to 1977). Other major differences in the characteristics of the subjects across studies include age (grade of subject at first contact ranges from 8th to 12th) and geographic region (most samples are not nationally representative). Also, sample sizes often make comparison of regression slopes within and across studies tenuous when regression coefficients are compared without appropriate consideration of the sampling errors for the coefficients, as is often the case.

Table 1 About Here

Table 1 summarizes sample characteristics and the authors' interpretation of which coefficients differed for blacks and whites. I will verbally summarize the authors' interpretations of these differences for only a few of the studies. This summary should serve to familiarize the reader with common interpretations of the differences in regression slopes. See Gottfredson (1980) for a more detailed review of these studies.

Porter (1974) interpreted racial differences in magnitudes of coefficients across groups (reported in Table 1) and relative weights within groups (not reported here) according to Turner's (1960) distinction between "contest" and "sponsored" mobility. For blacks, conformity, an

expression of a middle-class world view, is encouraged by significant others in the socialization process, but ambition--measured by aspirations and expectations for a prestigious career--is not. Black's educational attainment is more dependent on conformity than it is on ambition. Conversely, whites are socialized to be ambitious as well as to conform to middle-class norms, but their attainment is more dependent upon ambition than it is upon conformity. Porter interpreted the absence of a direct effect of intelligence and significant others' influence on grades and of grades on educational attainment for blacks as suggesting that the sponsored mobility of blacks depends on being chosen, not upon performance.

Portes and Wilson (1976) interpreted results of their study as implying that the earlier variables in the model--socioeconomic status, mental ability, and academic performance--were stronger predictors of attainment for whites than for blacks. But the mediating variables--self-esteem and educational aspirations--were more important or equally important for blacks. The authors interpreted these findings to mean that "for the (white) majority academic grades, apart from psychological effects, appear to 'carry along' individuals toward predictable levels of achievement. Black grades, especially those from all-black schools, appear to be more irrelevant as marks of achievement within the schools themselves and as criteria of selection for higher education" (p. 429). Later (p. 430) they concluded that blacks move upward primarily through individual self-reliance and ambition while whites have at their disposal an additional set of "institutional machinery" which can carry them along despite subjective orientations.

Kerckhoff and Campbell (1977b) reported that the weakness of the status attainment model for blacks is attributable to the limited effect of SES of origin on educational outcomes, to the lack of consistency of academic performance for blacks, and to the greater importance for blacks of non-academic performance (staying out of trouble in school) relative to academic performance. They interpreted these findings as being consistent with Porter's (1974) notions about sponsored and contest mobility systems. Teachers promote or sponsor those blacks who have few disciplinary problems and not necessarily those who perform well academically. These conclusions are based in large part on the following findings: A model including a measure of disciplinary problems and two measures of grade point average (one from junior and one from senior high school) predicted educational attainment better for blacks than for whites. Measures of status background variables had no significant direct effects on any outcome for blacks with the exception of a direct effect of mother's education on early grade point average. Grades in senior high school were more predictable from grades in junior high school for whites than blacks, and a measure of disciplinary problems was more important than a measure of grade point average for explaining blacks' attainment while the reverse order of effects was observed in the white equation.

No cross-study agreement exists about specific race differences in the parameters of this model of educational attainment. Major discrepancies beyond those which are obvious from Table 1 exist among the studies. Whereas Portes and Wilson (1976) found educational expectations to be a strong predictor of attainment for blacks, Kerckhoff and Campbell (1977b) found no effect of aspirations on attainment for blacks. While both Portes and Wilson (1976), and Porter (1974), found school performance

to be insignificant for explaining attainment for blacks, Kerckhoff and Campbell (1977b) found that senior high school GPA was the only variable whose coefficient reached the $p < .1$ level of significance for blacks. Other discrepancies involve the determinants of educational expectations. Some studies (Hout and Morgan, 1975; Kerckhoff and Campbell, 1977b) implied that academic performance, but not mental ability, was predictive of educational expectations for black males. In contrast, DeBord, Griffin and Clark (1977) found school performance to be significant for all groups except black males and the effect of ability to be greatest for black males. Similar discrepancies exist with regard to the influence of significant others. Studies that combined the sources of influence found no effect for black males on their educational expectations. Hout and Morgan found peer effects for all groups but black males, and parental encouragement effects for all groups, but they were strongest for black males. (They also interpreted the large GPA effect as an indication of a strong teacher encouragement effect for black males.) DeBord, Griffin and Clark found almost the opposite. All three influences were significant for blacks, but encouragement from parents was much more predictive of educational expectations for whites than for blacks. Finally, the only difference that appeared with any consistency across studies--that academic performance is more important for predicting the educational attainment of whites than blacks--was disconfirmed by Thomas' study.

Resolving Differences Among Studies

As Jencks et al. (1979) recently demonstrated, differences in results based on different surveys may result from a myriad of seemingly arbitrary decisions that must be made by both individual researchers and survey

organizations. Differences in sampling frame, measurement procedures, attrition and categorization of data cause means, standard deviations and associations among the same variables to differ from survey to survey. At the level of the individual researcher, choice of population, definition of variables, recoding and transformation of variables and treatment of missing data are among the decisions that affect research results. Researchers are seldom aware of the ways in which "seemingly innocuous 'procedural' or 'methodological' decisions affect outcomes." (p. 289). The conclusion reached by Jencks et al. after investigating survey differences in depth is that "surveys agree well on the broad, general picture, but detailed interpretations must still be treated with some caution." (p. 282).

Several major sampling and procedural differences among the studies reviewed are likely causes of their discrepant results. Several subsample analyses of blacks are based on extremely small samples resulting in inefficient regression coefficients. Differences in the constructs included in the causal models on which the equations are based, in the particular operational measures used for the constructs and in their measurement reliabilities affect results. The use of different, often incorrect, criteria for identifying cross-race differences in regression coefficients in the various studies is another reason for the failure to replicate, as is the use of statistics which assume random observations with nonrandom samples. These sampling characteristics and procedural decisions affect the values of regression coefficients and introduce noise into comparisons of those coefficients. The remainder of this paper illustrates some possible consequences of these methodological sources of fluctuation for making substantive interpretations of regression slope differences.

A difference interpreted as substantively meaningful in one study may be regarded as noise in another. The variety of criteria used in the studies reviewed for identifying regression coefficient differences implies that the choice of an appropriate statistic is not always obvious. At least six different criteria were used in the seven studies reviewed here: One study required that the difference between the black and white coefficients exceed one standard error of the white coefficient; another required that it exceed 1.5 standard errors of the black coefficient. One study used a t-test to determine whether the difference could have arisen as a result of random fluctuation, given the white coefficients as population values. One used an F-test to see whether adding an interaction term for race times a given variable added significantly to the variance explained in the criterion. One study chose an arbitrary value and required the difference between the standardized regression coefficients for blacks and whites to exceed it before being considered important, and another simply used the "eyeball" method for detecting differences.

Standard statistical texts discuss appropriate techniques for identifying regression coefficient differences. Kerlinger and Pedhazur (1973, Chapter 8) and Hanushek and Jackson (1977, Chapter 4) suggest the use of interaction terms computed by multiplying the grouping variable (in this case race) by the predictor of interest. The statistical significance of the interaction term can be assessed with a t-statistic to test the null hypothesis that the interaction term's coefficient (if only one term is being tested) equals zero, or with an F-statistic to test the null hypothesis that adding the interaction term to the equation adds

nothing to the explained variance of the criterion. Another appropriate statistical test of the null hypothesis of equal slopes is a t-test for random variables with unequal variances.[1]

In all but one of the studies reviewed, the criteria used for identifying differences in coefficients was less stringent than is appropriate, resulting in the rejection of the null hypothesis of no difference too often.

Departures from randomness in the sampling designs for surveys add another source of nuisance fluctuation to regression coefficients when the sampling characteristics are not taken into account in the analysis stage. In particular, nonindependence of observations (implying unequal or correlated error variance across observations) biases the results of standard statistical tests by causing standard errors to be underestimated and, again, too often rejecting the null hypothesis of no difference. The sampling designs for both the Youth in Transition and the National Longitudinal Surveys, two large-scale national samples used in the studies reviewed, were multi-stage cluster designs resulting in nonindependence of observations.

Table 2 About Here

A simple demonstration of the consequences of violating the non-independence assumption is illustrated in Table 2. This table shows proportions of variance explained by additive models and models including race interaction terms for each equation implied by the Wisconsin model of status attainment. Data are from the Youth in Transition Project (Bachman, 1975). See Appendix A for descriptive data on the observed

measures. The significance level of increments to explained variance of the interaction model over the additive model are tested with an F-test.

Global F-tests like these are, of course, not useful for testing hypotheses about specific interactions--they merely alert the researcher to the possibility of an interaction with one or more of the variables in the equation. Such tests are found frequently in comparative status attainment studies, and yield results similar in terms of magnitude of increments to those in the top panel of Table 2.

The bottom panel of Table 2 shows parallel information for increments due to interactions with random variables. All whites in the YIT sample (N=1912) were assigned a random grouping variable so that seven nonoverlapping groups with N's ranging from 239 to 289 could be identified and the significance of interaction terms computed using these random grouping variables was tested.

The table shows that increments due to the random interaction terms often are larger than those due to race interactions. Clearly, using the standard F-test is inappropriate with these data. The test should reject the null hypothesis (that the addition of the interaction terms does not increase the prediction of the criterion) in 1.75 of the 35 random tests at the .05 level and .35 times at the .01 level. Instead it is rejected 16 times at the .05 level and 9 times at the .01 level.

Cross-group comparisons of specific regression coefficients using a standard t-test (see footnote 1) yield equally questionable results. Coefficients estimated for random white subgroups diverge as much or more

from the values estimated for the full white sample than do those estimated for the black subsample. Clearly, the use of standard statistical tests with these data yield misleading results.

It is sometime possible to adjust for heterogeneity of error variance using techniques familiar to statisticians. Generalized least squares (Hanushek and Jackson, 1977, Chapter 6) is one such technique; design effects (a measure of the extent to which standard statistical formulas underestimate actual standard errors) are another. Bachman, O'Malley and Johnston (1977, Appendix B) provide approximations for standard errors adjusted for nonindependence using a design effect that was calculated for the entire Youth in Transition sample. They chose not, however, to provide a design effect that could be used for the black subsample, where the problem of nonindependence is much more severe (over two-thirds of the blacks are located in only eight of the 87 schools sampled).

The original investigators of the Youth in Transition data have consistently and repeatedly discouraged the study of race differences using these data because the generalizability of results from the black subsample is severely limited. Differences within the black subsample based on differences in school and community environments are great, and the likelihood is high that observed differences between the blacks in the sample and other subgroups result from school differences rather than race differences because the blacks are clustered in only a few, primarily segregated schools.

Solely to illustrate the need for adjusting for nonindependence of observations before applying standard statistical tests when using the Youth in Transition data, I used Bachman et al.'s design effect to

adjust the standard errors of regression coefficients for the total white, black, and random white subgroups in the exercise described above. When the t-tests are repeated after making this correction, most differences between coefficients for the total white and all other groups are reduced to nonsignificance.

The preceding paragraphs illustrate an obvious point: The researcher's decision about how to test for the presence of group differences in regression coefficients has serious consequences for the study's conclusions, and the problem is worse when data do not abide by the assumptions required by standard statistical tests. The choice of an appropriate statistic is not always obvious, though. Had I adopted the criteria for identifying race differences in regression coefficients used in the studies reviewed earlier, I would have concluded that substantively interesting race differences exist. Instead I conclude that the observed differences are, by and large, due to the inefficiency of the sample for calculating precise estimates.

Three major possible sources of discrepancies among the studies reviewed--small subsample sizes resulting in inefficient regression weights, different causal models and different methods for identifying differences--have been discussed. In an effort to uncover cross-study consistencies by controlling for these major differences, I reanalyzed data from only those studies based on subsamples of at least two hundred cases using a common causal model and method for identifying regression coefficient differences.[2]

Regressions were computed separately for each race group using the original Wisconsin model (Sewell, Haller, and Portes, 1969). This

entailed excluding variables such as "conformity to middle-class norms" and "self-esteem" which are unique to one or another study. Also, for those studies that used disaggregated measures of some of the model's constructs (Debord, Griffin and Clark, 1977; Thomas, 1980), I included all measures as indicators of the constructs in the Wisconsin model (LISREL was used for all reanalyses). Multiple indicators were used for the Significant Others' Influence construct--reports by teachers, peers and parents were available--and the Socioeconomic Status construct--measures of parents' education, fathers' occupation and (in Thomas only) a Household Index were used.[3]

Because the reanalyses are based on published correlation matrices, it is not possible to follow the procedures suggested by Kerlinger and Pedhazur (1973) or Hanushek and Jackson (1977) to test for statistically significant increments to explained variance in the criterion due to the interaction terms. Instead, I chose to test the null hypothesis that the regression coefficients for the black and white subsamples are equal (in each study) with a t-statistic for random variables with unequal variances.

This is not an entirely appropriate test. It does not explicitly correct for the nonhomogeneity of variance across observations caused by the cluster sampling designs used in many of the studies, although the use of separate variance estimates for blacks and whites helps somewhat to offset this problem to the extent that blacks and whites are highly segregated in schools (which is the case at least in the Youth in Transition data). This test is also flawed because it assumes that each test is independent of other tests, which is not the case because the values of

the regression coefficients in a given equation are not independent. Despite these problems, I considered it to be acceptable for the present task, which is to apply a uniform criterion for identifying coefficient differences to the results of several studies rather than to learn about actual race differences in regression coefficients.

Table 3 About Here

Table 3 summarizes the results of the reanalyses of four studies. Little consistency emerges in the results. Some of the differences reported in the original studies are not upheld in the reanalysis. All but one of the reported differences in the effects of SES are no longer significant. Four of the seven differences found are not replicated, i.e., are found in only one study. The effect of Aptitude on Level of Educational Aspirations was found to differ by race in two of the three studies including that test, but the direction of the "advantage" was different in each study. The two remaining differences, Aptitude on Academic Performance, appearing in three of the four reanalyses, and Academic Performance on Significant Others' Influence, appearing in two of the studies, all indicate a larger effect for whites than for blacks.

Reliability, Validity and Interpreting Slope Differences

I have so far shown that in general, specific black-white regression slope differences do not replicate across studies. This finding constitutes sufficient reason for pause in interpreting the observed differences in terms of substantively meaningful processes. Yet, even if we could place confidence in the observed regression coefficient differences, other alternative hypotheses must be eliminated before the researcher entertains a substantive explanation.

Imperfect measurement of constructs constitutes another source of variation in regression slopes. Regression coefficients are biased downward to the extent that the constructs they purport to describe are invalidly measured. Differences across groups in the construct validity of measures can render comparisons of their regression coefficients useless. For example, if we wish to determine the effect of investing in vocational preparation on later income, and choose to measure the investment by the number of years of college completed, we are likely to observe a larger regression coefficient for academics than for machinists. One possible explanation for this is that machinists do not experience as high a rate of return on their investments as do academics. An alternative and more plausible interpretation is that the construct--investment in vocational preparation--is not validly measured by college attendance for machinists and that the regression coefficient for that group is biased downward.

Bielby, Hauser, and Featherman (1977) investigated the consequences of ignoring differential measurement error across groups. They used retrospective data on socioeconomic background and self-reports of educational attainment collected at three points in time, systematically varied the specification of the measurement properties for each group and examined the fit of the data to each model. They found more measurement unreliability among the black than the white subsample, and that ignoring measurement error led to misinterpretations of their data.

To illustrate the consequences of different specifications of the measurement model for the problem at hand, I focus on the one black-white difference in the model which was replicated in more than half of the studies reviewed--the effect of Mental Ability test scores on Academic Performance.

The data used for this demonstration are all black and white males who participated in the Base Year (1972) of the National Longitudinal Study (NLS) of the High School Senior Class of 1972. These are the same data used in Thomas' study except that the present study included the respondents who did not have data for the standardized mental abilities tests (37% of the black and 28% of the white males) and computed pairwise present correlation coefficients, whereas Thomas' study excluded those cases from all analyses. Means, standard deviations and correlations for those data appear in Appendix A.

The point of this exercise is to demonstrate the effect of various ways of dealing with imperfect measurement on conclusions about race differences in regression coefficients. Measurement models were developed for most constructs in the Wisconsin model using multiple indicators available in the NLS data. By manipulating equality constraints across black and white subgroups[4] for segments of the model (measurement and structural), it is possible to assess the relative goodness of fit of the different models. Differences between the black and white coefficients for the variables in the equation predicting academic performance are also examined for the various specifications.

Model A in Table 4 estimates the parameters for the model shown in Figure 1 separately for each of the race subsamples. This model fits the data better (χ^2_{D-C} = 1450, df = 41) than Model D, which treats the two populations as though they were from a single population. This implies that at least some element of the model differs from the two groups. Models B and C are attempts to narrow down the possible locations of

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Figure 1 and Table 4 About Here

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the differences. Model B constrains all structural coefficients (those

marked with a solid line in Figure 1) to be equal for the black and white subsamples and allows the measurement coefficients (marked with dotted lines in Figure 1) to be estimated separately for each group. Model C reverses that procedure. Relaxing the equality constraints on the measurement model (Model B) improves the model's fit (over Model D) more (χ^2_{D-B} = 1382, df = 27) than does relaxing the equality constraints of the structural parameters (over Model D) (χ^2_{D-C} = 447, df = 21). In other words, allowing only the measurement of the constructs to vary across groups accounts for 95% of the difference between the best and worst fitting models, while allowing only the structural coefficients to vary accounts for only 31% of that difference. This implies that the fundamental models differ less across race than do the reliabilities of the measures.

Recall from Panel 4 of Table 3 that Thomas' analysis of the NLS data which specifies perfect measurement of the constructs implied that the effect of mental ability on academic performance is greater for whites than for blacks. Results based on the models in Table 4, all of which allow for imperfect measurement, should be contrasted to that finding.

The regression coefficients reported in Table 4 show that once estimates are "corrected" for differential measurement reliability (Model A), the oft-observed black-white difference in the effect of Mental Ability on Academic Performance disappears. Only when the model forces all black-white difference in the correlations of the observed variables to be represented in the structural coefficients (Model C) does it reappear.

The conclusion to be drawn from this illustration is not new. Social scientists have been aware of the effects of imperfect measurement

on the value of regression coefficients for decades. Yet typical research in this area has neither corrected regression coefficient differences for the effects of differential reliability in order to get cleaner estimates (as textbooks such as Cohen and Cohen, 1975, suggest they should), nor investigated the sources of differential measurement error across groups.[5] The conclusion, once again, is that race differences in regression coefficients have been overstated in previous research.

Summary and Conclusion

I have presented evidence from a variety of sources that converges on the conclusion that substantive inferences about race differences in the educational attainment process are unwarranted on the basis of differences in regression coefficients in the published literature. Results of studies examining race differences in the attainment process over the past decade do not agree on the nature of the differences observed, and this conclusion is upheld even when major differences in the samples, models and methods are held constant. Additional doubt is cast on substantive interpretations of the observed differences when a large portion of the observed race differences in regression coefficients is found to be due to differential measurement properties of the subsamples.

Regression slope differences in previous studies comparing structural models of educational attainment for blacks and whites constitute highly ambiguous evidence on which to base statements about race differences in the educational attainment process. Much of the weakness of the evidence may be attributed to the inadequacy of most data used for answering questions about comparative status attainment. It is often

difficult, if not impossible, to compensate for unfortunate characteristics of the samples such as unreliable measurement and heterogeneity of error variance due to cluster sampling designs. In short, the study of statistical interactions requires deliberate data collection strategies that anticipate and compensate for problems such as differential measurement properties. Representative samples are useful for learning about the general picture, but most often do not provide the power needed to examine interactions. Designing creative studies that focus better on the questions to be answered holds more promise than do continuing efforts to squeeze precise parameter estimates from data that lack the power to address the questions.

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Footnotes

1. This test statistic is:

$$t = \frac{b_b - b_w}{\sqrt{\text{st. err}_b^{\,2} + \text{st. err}_w^{\,2}}}$$

A correction for the degrees of freedom reflecting unequal sample sizes (Hays, 1963) can also be used. Other tests are possible. For example, a goodness of fit of the overall model to the data might be used as the criterion for accepting or rejecting the notion of statistical interaction. The fit for models specifying equality constraints on parameters across groups can be compared to that for models which allow parameters to be estimated separately for each group. Such a test is possible with LISREL IV (Jöreskog and Sörbom, 1978).

2. Published correlation matrices, means and standard deviations were available for all but one of the studies included in this reanalysis. The data for the study, which did not publish the necessary information (Thomas, 1980) was supplied by its author.

3. The choice of indicators for each of the constructs was determined solely by the requirement of equivalent measures across all studies. The intent of this exercise is to eliminate obvious differences among the studies in order to uncover consistencies rather than to estimate true parameters for the status attainment model. Hence, although different specifications (such as inclusion of other psychological variables or disaggregating significant others' influence) are superior, some correctness must be sacrificed here.

4. This can be accomplished using LISREL IV (Jöreskog and Sörbom, 1978). When an equality constraint for any parameter is imposed, the groups are analyzed simultaneously holding that parameter constant across the groups.

5. The latter course of research seems to be a promising approach for furthering our understanding of race differences in attainment. The measurement differences which appear to be a nuisance in status attainment research may tell us much about attainment. Low measurement reliability for the constructs in the model may indicate an unwillingness or inability to cooperate with the researcher, or it may indicate that the instruments used to measure the constructs are biased.

Figure Caption

Figure 1: LISREL Model of Educational Attainment. Note: Descriptions of measures along with their means, standard deviations and correlations for black and white subgroups appear in Appendix A. Dotted lines (---) represent "structural" paths, solid lines represent "measurement" paths, and irregular lines (-·-·) represent unanalyzed correlations or residuals.

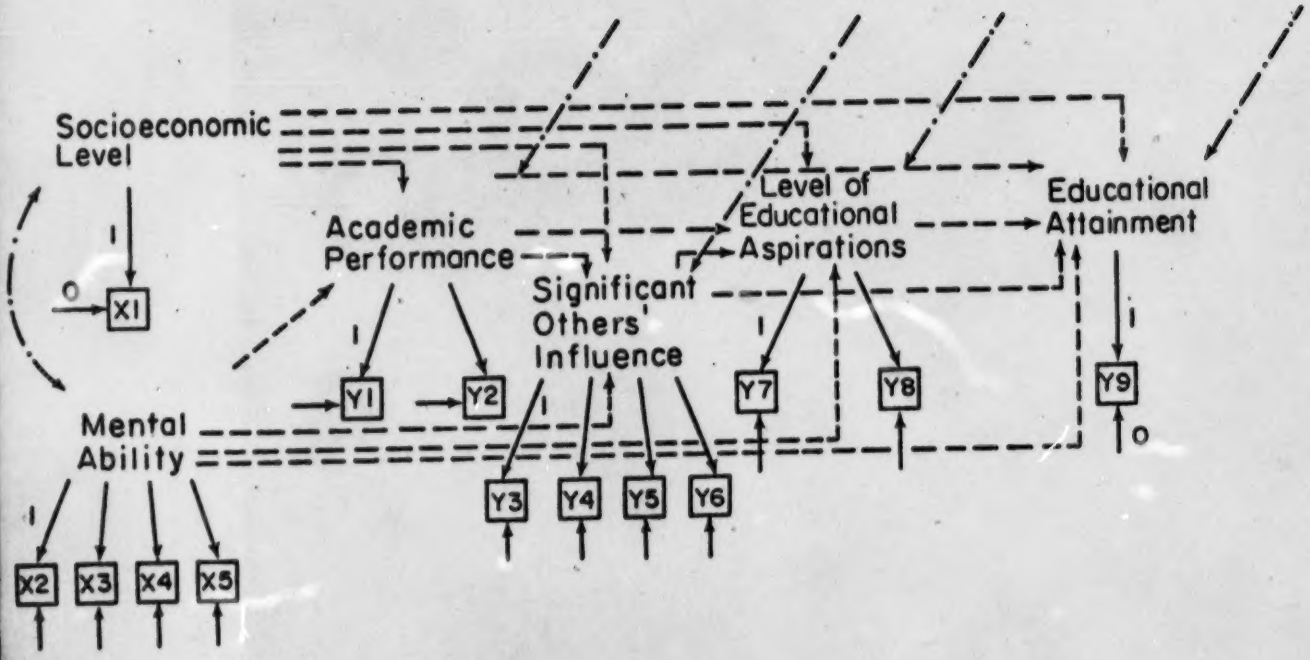
Socioeconomic Level
Academic Performance
Level of Educational Aspirations
Educational Attainment
Significant Others' Influence
Mental Ability
1
0
X1
Y1
Y2
Y3
Y4
Y5
Y6
Y7
Y8
Y9
X2
X3
X4
X5

Table 1

Race Differences in Regression Coefficients of Educational Attainment Model Reported in Seven Studies--Males Only

Author & Date	Sample	Sample Size[d] Whites	Sample Size[d] Blacks	Grade at Base Year	Years Data Collected	Predictor Variables Included[a]	Differences Reported for Equation Predicting: Educational Attainment[c]	Level of Occupat. Aspiration	Level of Educat. Aspiration	Parental Encouragement	Significant Others Influ.	Grade Point Avg.
Porter (1974)	Proj. Talent (the 40.6% that responded to the follow-up questionnaire)	14891	435	12	1960-1965	GPA (self-report)	W	--			--	--
						LOA	0	--			--	0
						Conformity	0	B			--	0
						SOI	W	W			--	0
						Creativity		0			0	0
						APT		0			0	W
						FAOCC	W	0			W	0
Hout and Morgan (1975)	All 12th grade public school students in Louisville, KY.	389	190	12	1973	LOA (Friend)		0	--	--		--
						LEA (Friend)		--	W	--		--
						PARENC		B	B	--		W
						GPA (school records)		B	B	0		--
						APT		W	W	--		0
						FAOCC		B	0	W		0
						HED		0	0	0		0
						SIBS		--	0	W		--
Portes and Wilson (1976)	Youth in Transition	1912	256	10	1966-1970	LEA	0		--		--	--
						Self-Esteem	B		0		--	--
						SOI	0		0		--	--
						GPA (Self-report)	W		0		0	--
						APT	0		W		W	W
						SES	0		W		W	0
Kerckhoff and Campbell (1977a)	All 12th grade community school system students in Fort Wayne, IN	987	74	12	1969	LEA			--			
						PARED			W			
						MOED			--			
						APT			W			
						GPA (school records)			0			
						Fatalism			B			
Kerckhoff and Campbell (1977b)	All 9th grade students in 5 of the 13 Fort Wayne, IN public junior high schools	380	113	9	1969-1974	LEA	W		--			--
						GPA (school records)[b]	W		W			--
						Disciplinary Problems	B		0			--
						FAOCC	W		W			0
						FAED	W		W			W
						MOED	0		0			0
						SIBS	0		0			W
						APT	0		W			0
Dehord, Griffin, and Clark (1977)	Those students enrolled in 23 Mississippi schools who answered all questionnaire items (46%)	1014	439	8-12	1972	LOA		--	--	--		--
						LEA		--	--	--		--
						TCHENC		0	0	--		--
						PARENC		W	W	--		--
						PEER PLANS		0	0	--		--
						GPA (school records)		0	0	0		--
						APT		0	B	0		0
						FAED		0	0	0		W
						MOED		0	0	B		0
						HOCC		W	0	0		0
Thomas (1980)	Subsample of National Longitudinal Sample for which standardized test data and SES data exist (64.5% of entire sample.)	4758	346	12	1972-1974	LEA	0					
						Perceived College Ability	0					
						SOI	0					
						Curriculum enrollment	W					
						Rank in class (school records)	B					
						APT	B					
						SES	B					

Information for these outcomes not reported by author

Note: Interactions for variables included in only one study are not shown on this table. No race interactions were reported for their coefficients except for the following: Self-esteem depends on Aptitude for blacks and not whites (Portes and Wilson, 1976); Teacher encouragement depends more upon father's education for blacks than for whites (Dehord, Griffin and Clark, 1977); Counselor reports of Disciplinary problems depends upon measures of SES for whites and not blacks (Kerckhoff and Campbell, 1977b).

Notation in columns is as follows:
- 0 = no race difference reported
- W = race difference favoring whites reported
- B = race difference favoring blacks reported
- -- = model does not include this test
- blank = criterion not examined

[a] The following abbreviations are used in this table:
- LoA - Level of Occupational Aspiration (or expectation), measured in Duncan SEI prestige score.
- LEA - Level of Educational Aspiration (or expectation)
- SOI - Significant Others' Influence (usually a composite based on parents, teachers and friends encouragement to respondent to continue schooling).
- PARENC - Parental encouragement to continue schooling.
- TCHENC - Teacher and counselor encouragement to continue schooling.
- GPA - Grade Point Average
- APT - Aptitude test score
- FAED - Father's Educational level.
- MOED - Mother's Educational level.
- PARED - Parent's Educational level.
- FAOCC - Father's Occupational Prestige (Duncan SEI score)
- HOCC - Head of Household's Occupational Prestige
- HED - Head of Household's Educational level

[b] A measure of Senior High GPA was also included in this study, but to preserve comparability only Junior High GPA is reported here.

[c] Measured by years of education attained in all studies but Thomas (1980). There it was measured by a dummy coding of attended college/did not attend college.

[d] For the Portes and Wilson (1976), Kerckhoff and Campbell (1977b) and Thomas (1980) studies, the sample sizes given are for the base year of the surveys used. Numbers of cases on which the correlations were based were provided only by Kerckhoff and Campbell. For that study, actual N's for whites ranged from 316-390 and for blacks from 64-113.

Table 2

Proportions of Variance Explained and Increments to Explained Variance due to Race Interactions and Random Grouping Variable Interactions

		Criterion				
		Academic Performance	Significant Others' Influence	Level of Educational Aspirations	Level of Occupational Aspirations	Educational Attainment
R^2 for model with no interactions		.199	.133	.198	.279	.481
R^2 for model with all race interactions		.222	.140	.206	.284	.490
Increment due to race interactions		.023**	.007*	.008**	.005	.009**
Increment due to random grouping variable interaction for group number:	1	.000	.013**	.014**	.018**	.007**
	2	.001	.009**	.003	.003	.007**
	3	.002	.006*	.002	.003	.012**
	4	.001	.004	.003	.003	.005*
	5	.000	.000	.001	.005	.056**
	6	.001	.003	.005*	.013**	.001
	7	.000	.000	.003	.002	.002

*$p < .05$

**$p < .01$

Table 3

Unstandardized Regression Coefficients for Wisconsin Model

Predetermined Variables	Criterion Variables: Academic Performance		Significant Others' Influence		Level of Educational Aspirations		Educational Attainment	
	Blacks	Whites	Blacks	Whites	Blacks	Whites	Blacks	Whites
Data from Porter (1974); Black N=435, White N=14891								
Socioeconomic Status	.018	.008*	.029	.074**				
Aptitude	.006	.049**[b]	.068**	.074**				
Academic Performance	--	--	.016	.282**[b]	(no measure of educational expectations included in this study)			
Significant Others' Influence	--	--	--	--				
R^2	.006	.113	.133	.191				
Data from Debord, Griffin and Clark (1977); Black N=439, White N=1014								
Socioeconomic Status	-.011[a]	.076*	.127**	.082**	-.023	.018		
Aptitude	-.155**	.161**	.002	.013*	.126*	-.007[b]	(no measure of educational attainment included in this study)	
Academic Performance	--	--	.047	.052**	.059	.181*		
Significant Others' Influence	--	--	--	--	3.147**	6.266**[b]		
R^2	.240	.279	.188	.435	.383	.653		
Data from Portes and Wilson (1976); Black N=256, White N=1957[c]								
Socioeconomic Status	-.041	.022	.055*	.094**	.011	.024**	.027*	.027**
Aptitude	.499**	1.637**[b]	.041	.210**[a]	-.044	.035*[b]	.115*	.097**
Academic Performance	--	--	.094*	.064**	.046**	.038**	.026	.062**[a]
Significant Others' Influence	--	--	--	--	.055*	.059**	.034	.040**
Level of Educational Aspirations	--	--	--	--	--	--	.452**	.404*
R^2	.056	.271	.066	.186	.116	.347	.279	.433
Data from Thomas (1980); Black N=346, White N=4758[c]								
Socioeconomic Status	-.156	.029	.029*	.025**	.109*	.138**	.057*	.039**
Aptitude	.428**	.624**[b]	.015*	.008**	.128**	.092**	.019	.017**
Academic Performance	--	--	.001	.010**[b]	.048*	.073**	.025*	.022**
Significant Others' Influence	--	--	--	--	2.091*	2.202**	.789*	.393**
Level of Educational Aspirations	--	--	--	--	--	--	.154**	.207**
R^2	.113	.268	.183	.168	.319	.470	.378	.474

*Coefficient is significant at the $p < .05$ level.

**Coefficient is significant at the $p < .01$ level.

[a]Difference between black and white coefficients is significant at the $p < .05$ level.

[b]Difference between black and white coefficients is significant at the $p < .01$ level.

[c]Sample sizes given are for the base years of the surveys used. Numbers of cases on which the correlations were based were not provided.

Table 4

Relative Goodness of Fit and Regression Coefficients

for Models of Educational Attainment Allowing for Imperfect Measurement

Model Name and Description	X^2 Goodness of Fit, corrected for degrees of freedom[a]	unstandardized regression coefficients[b] Academic Performance on Socioeconomic Status		Mental Ability	
		Black	White	Black	White
A: No equality constraints across groups	2974	-.017(.012)	-.014(.004)	.232(.018)	.252(.005)
B: Structural coefficients constrained to be equal across groups	3042	-.015(.004)		.251(.005)	
C: Measurement coefficients constrained to be equal across groups	3977	-.018(.012)	-.014(.004)	.174[c](.012)	.258(.005)
D: Structural and measurement coefficients constrained to be equal across groups	4424	-.013(.004)		.249(.005)	

[a] This statistic is computed by subtracting the models' degrees of freedom from their X^2 values.

[b] Standard errors are in parentheses.

[c] Difference between black and white coefficient is statistically significant at the $p < .001$ level.

Table A-1

Descriptions of Variables in Wisconsin Model of Educational Attainment: YIT Data

Abbreviation	Description[a]
SEL	Socioeconomic Level: A summary index, consisting of six equally weighted components: father's occupational status; father's educational level; mother's educational level; number of rooms per person in home; number of books in home; checklist of other possessions in home. See Bachman (1970, Appendix B) for a detailed description of the construction and validity of this scale.
MA	Mental Ability: Factor score from a principal components factor analysis of three ability tests: 1) Ammons Quick Test of General Intelligence; 2) GATB, part of J-Test of Vocabulary Level; and 3) Gates Reading Comprehension.
AP	Academic Performance: Respondent's report of his average grade received in his classes for the past year.
SOI	Significant Others' Influence: An index computed on the basis of two questions: "How do these people feel about whether you should go to college?" and "What if you decided not to go to college--how would they feel?" A score of 3 was given if the respondent was being encouraged to attend college and bad feelings would result from non-attendance, a score of 2 was given if the respondent was being encouraged but the referrent wouldn't care if he or she decided not to attend, and a score of 1 was assigned if the respondent was not being encouraged to attend college. Scores for questions referring to father, mother, teacher and friend were summed and the resultant composite score was standardized.
LEA	Level of Educational Aspirations: This index is based on responses to the questions regarding short range educational plans. A code of "3" was assigned if the respondent definitely planned to attend graduate or professional school, "2" if he definitely planned to attend college, "1" if he definitely planned to complete high school, and "0" otherwise.
LOA	Level of Occupational Aspirations: Duncan prestige ranking for the occupation named by respondent in response to the question, "In the long run, what sort of work do you think you might do for a living?"
EDATT	Educational Attainment: An index constructed by adding standardized scores for the following variables. a) Information about educational pursuits completed or in progress recoded into a scale ranging from "0" (have not yet completed high school or earned a high school equivalency), through "6" (have attended or am attending a graduate or professional school after college). b) "How many years of schooling have you completed?", and c) "What is the highest degree you have earned?"

[a] LEA and LOA were constructed using responses from time 2, EDATT from time 5, and all other variables from time 1.

Table A-2

Means, Standard Deviations, and Pairwise Present Correlations for Variables in Wisconsin Model of Educational Attainment: YIT Data

	SEL	MA	AP	SOI	LEA	LOA	EDATT	$\bar{x}$	SD	Valid N
SEL	--	.435	.252	.312	.348	.350	.428	509.747	77.219	1868
MA	.467	--	.482	.313	.331	.469	.492	.154	.801	1912
AP	.058	.247	--	.264	.377	.403	.510	40.239	7.431	1904
SOI	.192	.097	.177	--	.277	.317	.308	5.680	2.654	1433
LEA	.104	.002	.171	.135	--	.427	.497	1.401	.770	1623
LOA	.248	.312	.143	.148	.265	--	.507	59.830	24.709	1318
EDATT	.301	.396	.256	.246	.353	.270	--	.202	2.891	1359
$\bar{x}$	449.973	-1.057	38.254	5.484	1.350	53.282	-1.431			
SD	78.084	1.063	6.463	2.843	.895	24.674	2.174			
Valid N	226	250	256	100	197	101	119			

Note: Statistics for blacks appear below the diagonal and for whites appear above the diagonal.

Table A-3

Descriptions of Observed Variables in Model of Educational Attainment (Figure 3): NLS Males[1]

Symbol in Figure	Abbreviation	Description
X1	SES	Index of socioeconomic status resulting from factor analysis of father's education, mother's education, parents' income, father's occupation and household items.
X2	VOCAB	Vocabulary subtest score (standardized)
X3	PICTURE	Picture Number subtest score (standardized)
X4	READING	Reading subtest score (standardized)
X5	LETTER	Letter groups subtest score (standardized)
Y1	SLFGPA	Respondent's report of grades so far in high school,
Y2	GPA	Grade Point Average from school records[2]
Y3	FAEX	Response to a question asking how much schooling respondent's father wants respondent to get. Responses range on a 6-point scale from "quit high school without graduating" to "go to graduate or professional school."
Y4	MOEX	Same as above, but refers to mother
Y5	TCHINF	Response to a question concerning influence of teachers and counselors on college attendance. Possible responses are, "discouraged me," "didn't try to influence me," and "encouraged me."
Y6	PEERPLAN	Respondent's report of his or her close friends' plans for next year. Coded "2" for college, "1" for vocational, technical, business or trade school and "0" otherwise.
Y7	EDASP	Highest level of education respondent would like to attain, using same response scale as for Y3.
Y8	EDEX	Highest level of education respondent plans to attain, using same scale as for Y3.
Y9	ATTAIN	Highest level of education or training respondent attained by October, 1976. Responses range from finished high school through finished Ph.D. or advanced professional degree.

[1] Variables X1 through Y8 are taken from the base year questionnaire which was administered in 1972 when the students were seniors. Y9 was taken from the third follow-up questionnaire which was administered four years later.

[2] This score was imputed from reports of actual grades (letter or grade point average) and rank in class.

Table A-4

Means, Standard Deviations, and Pairwise Present Correlations for Observed Variables in Model of Educational Attainment (Figure 3): NLS Males

	SES	VOCAB	PICTURE	READING	LETTER	SLFGPA	GPA	FAEX	MOEX	TCHINF	PEERPLAN	EDASP	EDEX	ATTAIN	$\bar{X}$	SD	Valid N
SES	--	.334	.157	.306	.251	.209	.200	.428	.398	.147	.338	.360	.424	.409	1.030	6.717	8532
VOCAB	.253	--	.253	.647	.428	.410	.450	.405	.407	.226	.338	.379	.411	.424	51.659	9.699	6205
PICTURE	.138	.189	--	.322	.397	.335	.332	.266	.260	.188	.221	.237	.273	.293	49.676	9.730	6205
READING	.220	.611	.298	--	.532	.423	.458	.420	.419	.264	.330	.402	.436	.422	51.548	9.497	6205
LETTER	.225	.402	.372	.548	--	.392	.412	.375	.362	.255	.321	.331	.370	.375	50.662	9.427	6205
SLFGPA	.086	.173	.168	.257	.212	--	.706	.394	.396	.286	.321	.405	.477	.447	5.389	1.423	7943
GPA	.082	.238	.253	.321	.314	.503	--	.386	.389	.277	.313	.384	.456	.450	7.082	3.047	6544
FAEX	.310	.269	.170	.323	.339	.170	.179	--	.910	.361	.448	.684	.748	.561	4.354	1.251	6544
MOEX	.328	.356	.187	.390	.360	.182	.216	.838	--	.357	.451	.682	.739	.547	4.417	1.222	6671
TCHINE	.044	.141	.083	.192	.189	.167	.138	.135	.236	--	.268	.320	.314	.267	2.612	.543	6411
PEERPLAN	.185	.260	.178	.221	.218	.108	.140	.232	.274	.164	--	.453	.507	.452	1.258	.933	7606
EDASP	.239	.293	.227	.356	.324	.236	.190	.513	.485	.162	.353	--	.732	.544	4.853	1.274	4572
EDEX	.280	.348	.135	.381	.327	.304	.246	.529	.562	.205	.371	.566	--	.646	4.215	1.384	4991
ATTAIN	.266	.319	.214	.346	.325	.241	.314	.372	.390	.205	.280	.409	.429	--	3.309	1.953	7658
$\bar{X}$	-5.949	42.078	44.086	42.042	40.906	4.901	5.646	4.283	4.328	2.683	.983	4.645	4.047	2.709			
SD	5.886	7.334	9.250	9.055	10.477	1.287	2.902	1.308	1.291	.545	.954	1.338	1.406	1.825			
Valid N	1336	859	859	859	859	1249	1032	757	893	901	1207	378	448	1106			

Note: Statistics for blacks appear below the diagonal and for whites appear above the diagonal.